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A REDESCRIPTION OF *PARIOTICHUS* *INCISIVUS* COPE.

E. C. CASE.

AN unusually perfect specimen of this genus and species in the paleontological collection of the University of Chicago makes it possible to complete the description of the species, hitherto known only from a fragmentary skull, and to add some points to the characters of the genus, also known largely from the skull.

The family *Pariotichidae* was established by Cope in 1883 (3). He says (p. 631) "*Pariotichus* and *Pantylus* and probably *Ectocynodon* must be referred to a special family, the *Pariotichidae*, which has teeth like the *Edaphosauridae* but differs from it in the entire over-roofing of the temporal fossae." There is no mention here of the family belonging to the order *Cotylosauria*, but this is evidently the position in which he would have placed it, as it is regarded always in later writings as belonging in that order or suborder, as he then regarded it.

In 1895 he gave a tabular statement of the characters of the families in the order *Cotylosauria* (4):

I. Teeth in a single series.

Teeth not transversely expanded; vertebral centra with surfaces only ossified; no hyposphen. . .	<i>Elginiidae.</i>
Teeth not transversely expanded; vertebral centra ossified; no hyposphen.	<i>Pariasauridae.</i>
Teeth with the crowns transverse to the axis of the jaws; vertebrae ossified and with a hyposphen-hypantrum articulation.	<i>Diadectidae.</i>

II. Teeth in more than one series in (one or) both jaws.

Teeth with cylindric roots; vertebrae ossified. . .	<i>Pariotichidae.</i>
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In 1878 (1) the genus *Pariotichus* was described (p. 508): "The temporal fossae were covered by a roof continuous with

the postorbital region; the zygomatic arch extends low down, producing a resemblance to certain tortoises. The orbits are small and lateral, and the muzzle is short, with terminal nares. Their exact character cannot be ascertained. The teeth are rooted, and have compressed obtuse crowns with cutting edge; they diminish in length posteriorly, and do not display any elongate canine. The cranial bones do not exhibit any sculpture." In 1883 (3) (p. 631) this last statement was corrected: "The surface of the cranium has been mostly weathered away in the type of *Pariotichus*, *P. brachyops*, and I suspect that it is really sculptured and not smooth, as I originally stated."

In 1895 (4) an analytical table of the genera of the *Pariotichidae* was given. In this table the genus *Ectocynodon* is united with *Pariotichus*:

I. External nostrils lateral.

a. Palatal and splenial teeth with compressed crowns.

Teeth equal, acute. *Isodectes* Cope.

Teeth increasing gradually in length anteriorly. *Captorhinus* Cope.

Teeth enlarged on the middle of the maxillary and anterior part of the incisive series. *Pariotichus* Cope.

aa. Palatal and splenial teeth obtuse, forming a grinding pavement.

Median maxillary and anterior incisor teeth enlarged. *Pantylus* Cope.

II. External nostrils inferior.

Mouth posterior in position, mandible short, and with a few acute teeth. *Hypopnous* Cope.

It is probable that *Helodectes* Cope pertains to this family.

In the same article (p. 443) there is given a more extended description of the genus *Pariotichus*. "The maxillary teeth display the enlarged median tooth characteristic of the species referred to *Ectocynodon*, although it is less prominent than in some of the latter, and it is probable that the premaxillaries display corresponding enlargement. The type of *Ectocynodon* (*E. ordinatus* Cope) is in the same condition as regards teeth of the premaxillary series, but a long tooth is present near the

mandibular symphysis, so that the characters are so far those of the other species referred here. The elongation of the maxillary tooth is more conspicuous than in the *P. brachyops*. In general this tooth is not absolutely very large, but the teeth anterior and posterior to it are small or very small. Besides the usual series of teeth on the maxillary bone, there are two or more series adjacent. In like manner on the mandible, beside the dentary series, there are two or three series, perhaps on the splenial bone, standing on a ledge on the same horizontal plane as the tooth-bearing edge of the dentary. In this genus, and probably in all the members of the family, the palate is roofed over posteriorly by the palatine bones. The pterygoids diverge early from the presphenoid region toward the zygomatic border, as in *Batrachia* generally. The mandibular articular surface consists of two cotyli placed transversely. The os tabulare is small, and is situated, as in other genera of the family, near the posterior junction of the supramastoid and supratemporal. The supraoccipital forms a narrow strip of the posterior border of the superior plane of the skull. The arrangement of the cranial bones is as I have described in the genera *Isodectes* and *Pantylus*, except that the prefrontal and postfrontal bones scarcely meet over the orbit, instead of separating the orbital border from the frontal. The occipital condyle, as in *Empedias*, is prominent, and has a median fossa.

"In *Pariotichus aguti* the vomers are elongate posteriorly and the palatines send an acute anterior process between them. The palatines are separated by a fissure which is narrow anteriorly and becomes wider posteriorly. Each interior border bears on its posterior two-thirds a row of small teeth. In this respect this genus differs from *Empedias*, where the palatines are closely appressed on the middle line. The suture between the palatines and the ectopterygoid is not easily made out, but this region descends below the maxillaries to opposite the middle of the inside of the mandible, as in many *Lacertilia*. Just anterior to the oblique angle which marks this descent a ridge of the palatines extends forwards and outwards, and for a short distance bears a row of teeth. These teeth, like those of the internal palatine series, are in a single row, differing in

this respect from the species of *Pariasaurus*, as described by Seeley, where they are in two rows period. The positions of the rows are the same in the two genera. The posterior border of the ectopterygoid supports a patch of teeth in several rows. They are much less developed in *Pariasaurus*.

"The pterygoids are slender and diverge from the interior part of the palatines outward, backward and upward, to the inner side of the quadrate. They bear no teeth. The sphenoid is deeply grooved on the middle line as in *Elginia*. Its lateral inferior keels project below the plane of the short basioccipital. There is no evidence that any of the rows of teeth of the upper jaw rise from the palatine bone; they appear to be maxillary in attachment.

"The specimen of *Pariotichus aguti*, on which the above observations are made, possesses, attached to the skull in nearly normal relations, seven vertebrae, a good deal of the scapular arch, and the right humerus. The fifth and sixth vertebrae have slender cervical ribs. The bodies of these, with that of the seventh, are the only ones whose inferior surfaces are exposed. I observe narrow faces for intercentra between them. Of the scapular arch the clavicle and a median element are preserved. The former has a narrow subvertical portion which rests on the anterior edge of the scapula, and a horizontal portion which is considerably expanded, contracting gradually to the middle line. The median element is T-shaped, with the median portion or stem rather slender. It is broken off posteriorly so that its apex cannot be described. It underruns the expanded clavicles, and may be, therefore, supposed to be a cartilage bone and a true sternum, and not an interclavicle. A superficial layer of the exposed part of this element is roughened by sculpture, and probably represents the interclavicle. The inferior layer of the expanded part of the clavicle is similarly sculptured. The humerus has greatly expanded extremities and a slender shaft of moderate length. The form is similar to that of *Pariasaurus*. There is an angulation of the distal extremity which represents the condyle. Entepicondylar foramen well developed; no ectepicondylar foramen."

An analytical table gives the characters of the various species (p. 445):

- I. The long maxillary tooth below the anterior border of the orbit.
 Head short, wide; orbits small, half interorbital width; length of skull about 25 mm. *P. brachyops.*
- II. The long maxillary tooth nearer the nostril than the orbit.
 - a. Sculpture reticulate.
 Interorbital and parietal sculpture reticulate; interorbital width 20 mm.; interior jaw teeth with round crowns. *P. incisivus.*
 - aa. Sculpture more or less in longitudinal ridges.
 Interorbital sculpture in longitudinal ridges; interorbital width 9 mm., equal orbit; maxillary tusk abruptly longer. *P. ordinatus.*
 Cranial sculpture in longitudinal ridges; orbit about equal interorbital width; skull equilateral, straight posteriorly; length 72 mm.; inner jaw teeth compressed. *P. isolomus.*
 Cranial sculpture partly reticulate, especially medially; orbit about equal interorbital width; width of skull three-quarters length; outline emarginate posteriorly, length 80 mm. *P. aguti.*
 Orbit oval; cranium 162 mm. long, and nearly as wide; posterior border emarginate; muzzle much contracted, entirely overhanging symphysis mandibuli. *P. hamatus.*

To these was added *P. aduncus* in a later article (6), characterized by the strong decurvature of the anterior end of the muzzle and the gradation in the size of the maxillary teeth instead of the single abruptly large one.

As the specimen here described has been identified as *P. incisivus*, it is necessary to give the generic and specific characters of *Ectocynodon incisivus*, under which name it was originally described. The generic description was given in 1878 (1) (p. 508): "Cranium short and wide, with large post-frontal bones and a large orbit. Cranial bones sculptured, but no lyra. Teeth rhizodont with elongate compressed crowns with anterior and posterior cutting edges. One of these

between the orbit and the nostril larger and longer than the others, and lying outside of the closed dentary bone. Mandibular symphysis not sutural, but ligamentous. Terminal mandibular tooth not small. Teeth not faceted, simple."

The species *incisivus* was described in 1886 (5) (p. 291): "The muzzle is quite prominent, a character somewhat exaggerated in the specimen by pressure. The nostrils are large, lateral in direction, and situated close to the end of the muzzle. The orbits are sub-round, of medium size, and look mainly upwards in the present condition of the specimen. One of the most important peculiarities of the species is the disproportionately large size of the first or anterior incisor or premaxillary tooth. The crown is conical and nearly straight, with an acute apex slightly posterior to the central point. Its section at the base is slightly angulate. The two other premaxillary teeth are much smaller, the third quite minute and with a sharp apex.

"There are three maxillary teeth separated by rather wide interspaces, anterior to the large tooth, which give character to the genus. The latter is abruptly large, but not equal in dimensions to the large first incisor. Posterior to it the maxillary teeth are closely placed, and with obtuse crowns. They commence very small, and increase in size posteriorly. At a point where the palatine or ectopterygoid, as the fact may be, joins the maxillary, the tooth-bearing surface is wide, and supports four rows of small, obtuse-crowned spaced teeth of equal size. This dental patch is triangular, with its long angles extending anteriorly and posteriorly. The latter angle terminates a little posterior to the middle of the orbit. The teeth have a small axial pulp cavity, and the dentine is perfectly simple.

"The head sculpture is well defined, and is reticulated in pattern."

Additional Description of the Head.—On one side, in the specimen here described, there are sixteen maxillary teeth visible; allowing for lost teeth, there were about nineteen in the series; this number is probably not constant for the species. The enlarged maxillary tooth, which is only slightly larger than the adjacent teeth, is the sixth from the anterior end, probably the seventh of the complete series. Posterior

to this tooth the teeth become smaller and more irregular in position; they are smooth and without anterior and posterior cutting edges. The teeth of the mandible and the premaxillary are as described by Cope, with the exception that in the posterior part of the mandibular series only are the teeth arranged in more than one row. The dentine of the enlarged internal incisor of the premaxillary shows some indication of a radial arrangement of the dentine.

The upper surface of the skull is so injured that it is impossible to make out the exact relations of the bones, but their

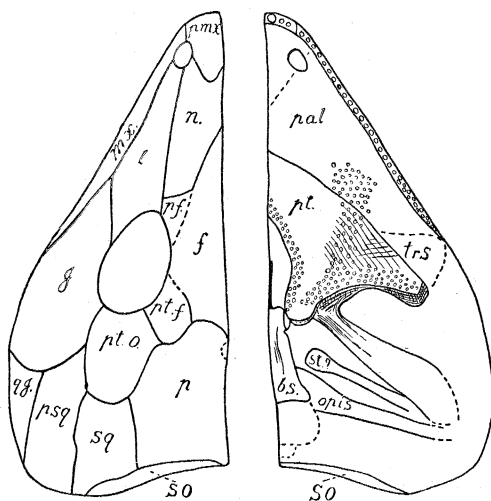


FIG. 1. — Upper and lower surfaces of skull. The extent of the lachrymal is adapted from Cope's figures, but is indicated in the present specimen as well.

general arrangement is shown in Fig. 1, in part suggested by Cope's figures. The character of the sculpture in the occipital and parietal regions is shown in Fig. 2.

The lower surface of the skull shows the general arrangement of the bones characteristic of the Permian reptiles; teeth are present in patches upon the vomer, palatines, and pterygoids. The pterygoids show the tripartite form characteristic of the *Pelycosauria*; the anterior process is broad and plate-like, and the anterior part of each bone joins that of the opposite side in the middle line; more posteriorly they diverge and form a vacuity, into which projects the stylus-like anterior end of the

basisphenoid (presphenoid): the edges of this vacuity are covered with small teeth set closely together. The posterior process is also broad and plate-like; it extends back to the quadrate which it joins; it is set at something of an angle with the rest of the bone. The third process is not so distinct from the rest of the bone as in the *Pelycosauria*; it is virtually a thickening of the posterior edge of the anterior process, but this is carried to a degree that demands description as a separate process. It extends directly outward from a point opposite the middle portion of the bone; the posterior edge is sharp and abrupt, while the anterior side slopes down gently to join the rest of the bone; this slope is covered with a patch of small blunt teeth, very closely set together; the patch is separated from the patch upon the borders of the median vacuity by a shallow groove; it is connected with the patch upon the palatine. The presence of this patch of many small blunt teeth upon the external process is one of the distinguishing features of the *Pariotichidae*, for in the *Pelycosauria* the teeth upon this process are few, and planted in distinct sockets. Opposite the origin of the external process there is developed on the inner edge of the bone a short blunt process, the basisphenoid process, which gives attachment to the basisphenoid bone (Fig. 1, *pt.*).

There is no trace of an ectopterygoid; it is probable that it was attached to the anterior process of the pterygoid, and did not join the external process except at the anterior side of the extreme end.

The basisphenoid is much as in other primitive reptiles, with the characteristic groove on the lower surface, between the basiptyergoid processes; the anterior end is continued as a long and slender process (presphenoid), which extends into the median vacuity between the pterygoids.

The posterior portion of the base of the skull is obscured by the crushed anterior cervical vertebrae and the distortion accompanying fossilization. A distinct opisthotic can be made out, and anterior to this a long slender element that appears to be a stapes. The basioccipital is completely obscured. The quadrate is covered by the bones of the temporal region and the articular portion of the lower jaw, but enough can be made out

to show that it was small and flat, and even in the natural condition was covered by the surrounding bones to a large extent. The arrangement of the bones of the lower surface is partly indicated in Fig. 1.

The lower jaw is of the same type as the modern *Sphenodon*; there is a rather low coronoid process, and the angle of the jaw extends posterior to the articulation.

The Vertebrae.—There are eighteen presacral vertebrae in the specimen; a break between the skull and the anterior end

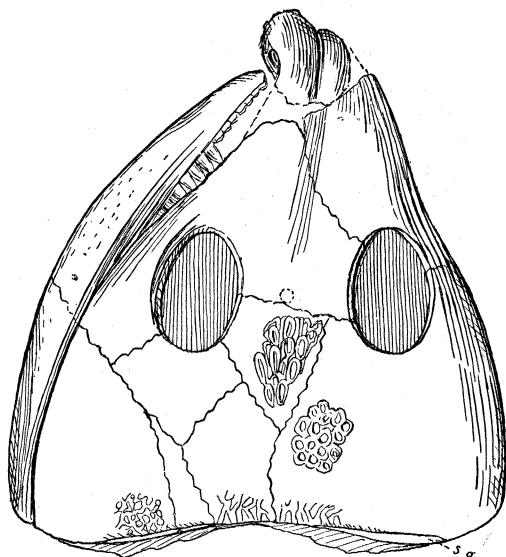


FIG. 2. — Superior view of skull. The sculpture of the surface is indicated in the different regions. *s.o.*, supraoccipital.

of the body suggests the possibility of one or more having been lost, but this is hardly probable; the author collected the specimen here described, and from the position of the bones and the condition of the matrix it seems that the column must be perfect. The number of presacrals is very interesting, as it is the characteristic number for *Pareiasaurus* and the turtles. The anterior two vertebrae have been badly crushed and lie upon the lower surface of the skull; enough can be seen to show that the atlas was a simple ring; the face for the occipital condyle shows that there was a better development of the

condyle upon the sides than in the middle, indicating a rather bipartite condition, such as is found to a greater degree in the *Gomphodontia*.

The vertebrae are all deeply biconcave, and there are wide spaces between the lower edges of adjacent vertebrae, which indicate the presence of intercentra. Between the seventh and eighth vertebrae there is a small bone which appears to be an intercentrum. The most striking thing about the vertebrae is their similarity to the vertebrae of *Pareiasaurus*. The neural arches are broad and flat, with rather swollen sides and very prominent anterior and posterior zygapophyses, whose faces look straight up and down. The spinous processes are short

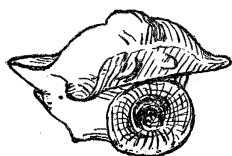


FIG. 3. — A posterior dorsal vertebra (natural size).

and stout, and seem to have been attached to some dermal ossification; in the anterior part of the column the processes are bifurcate. Fig. 3 will show the general appearance of a vertebra from the posterior part of the series. The most anterior

of the connected series of vertebrae lies immediately above the anterior ends of the coracoids; it has stout transverse processes that stand out at a right angle from the anterior part of the centrum and underlie for the most part the anterior zygapophyses; they are about as long as one-half the centrum. Attached to the transverse process is a long rib, wide at the two extremities and narrowed into a rather angular shaft in the middle portion; the proximal end is attached by the upper part to the transverse process, and by the lower to the intercentrum (the tubercula and capitula are not distinct). The distal extremity of the rib is wide and spatuliform; the whole rib is bent upon itself so that the two ends are directed at right angles to each other. The second vertebra bears a pair of ribs that differ from the first pair in that they are straight and longer; they are expanded proximally and distally. The transverse processes of the vertebrae grow smaller, until the last can be detected as a small tuberosity upon the ninth from the first rib-bearing one; it is probable from the size and rate of diminution that the last trace disappeared upon the eleventh; this would leave five verte-

brae without ribs. Other than the disappearance of the transverse processes and a gradual gain in stoutness, there is little change in the whole series (Fig. 4).

There are two vertebrae in the sacrum: the first bears a strong rib with an expanded distal extremity as wide as the length of the vertebrae; the second has a less well developed pair of ribs with the distal extremity hardly broader than the rest of the process (Fig. 5).

There are two caudal vertebrae attached to the sacra; they are much the same in appearance as the others, and have short

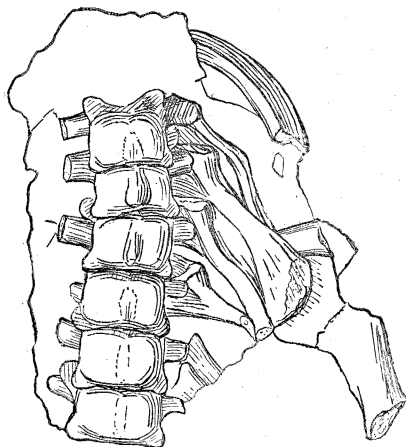


FIG. 4.—Dorsal view of anterior dorsal series.

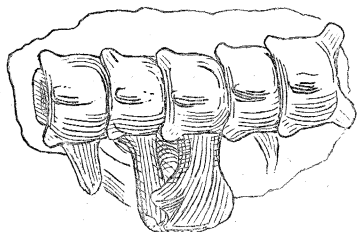


FIG. 5.—Dorsal view sacral vertebrae. The surfaces of vertebrae are restored.

strong ribs attached. A small fragment contains three caudals near the end of the tail; they show that the dorsal spines were much longer than in the dorsal region, and that there were rather long and slender ribs ankylosed to the vertebrae. Their size seems to indicate that the animal had a rather long tail.

The clavicles and the interclavicle are large and well developed, having much the appearance of the same bones figured by Cope in *Pariotichus aguti* (4) (Pl. VII, Fig. 2). The clavicle is there designated the episternum. The anterior end of the interclavicle is diamond-shaped in outline; the lateral parts of the head underlie the ventral ends of the clavicles; they have a rugose sculpture of fine lines. The posterior portion is continued into a cylindrical process at least twice as long as the rest of the bone; its distal end is somewhat rugose.

The clavicles are peculiar bones with spatuliform enlargements at either end; the ventral ends lie flat upon the interclavicle and coracoid; the dorsal end lies at an angle of about forty-five degrees to the ventral; the shaft is much smaller and has a triangular section; it is so bent that the two ends of the bone are directed at about

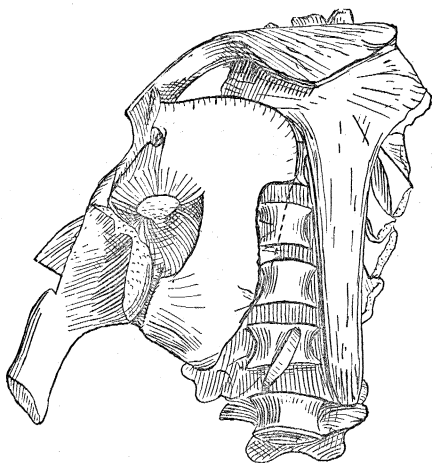


FIG. 6. — Ventral view of anterior dorsal series, showing pectoral girdle and humerus.

a right angle to each other. There is no trace of any cleithrum (Fig. 6).

The scapula and the coracoid are united into a single bone, and there is no trace of any suture between them; the cotylus for the humerus is deep, and the rim is prominent above and below. The edges are complete, with no traces of any fossae or serrations. There is no trace

of any coracoid foramen. The outline of the bone is very characteristic, as there is a complete absence of the posterior prolongation of the scapula; it is much more like the form found in the amphibians of the same period (Fig. 6).

The lower surfaces of the vertebrae in the sacral region are covered by the remnants of the pelvis. The anterior ends of the ilia are broken away, but a separate fragment shows that it was rounded rather than acuminate; the distal end joined the proximal part by a rather slender neck. The ischium and the pubis were joined on the middle line and extended far anterior and posterior to the acetabulum. The acetabulum is rather large, and was imperforate. All three bones take part in its formation.

The humeri of both sides are preserved in an imperfect condition; the proximal end is expanded into a thin flat plate with a scarcely distinct head; the shaft is comparatively stout, and is triangular in section; the distal end is turned at almost a

right angle to the proximal portion. It is large and expanded, with no trace of an entepicondylar foramen. The absence of the foramen is rather a surprising feature, but is distinctly an amphibian character, it is present in *Pareiasaurus*; instead of the entepicondylar foramen there is a deep notch, such as represents the ectepicondylar foramen in the *Pelycosauria*. The ent- and ectepicondylar tuberosities are large and prominent, but the condyles are not well developed.

The radius and ulna are represented by the proximal ends only. The ulna shows a definite but not well developed olecranon fossa. The front foot of the left side has been preserved; the distal ends of the radius and ulna are nearly in their normal positions; the bones of the carpus are all present, with the possible exception of the first carpal of the distal row. There are well-formed scaphoid and cuneiform bones, and between these an elongate element that was at first regarded as the missing metacarpal I, but it seems more probable that it is the lunare (intermedium); the upper end is incomplete, and the lower is much the same in appearance as the end of the metacarpals; on the other hand, it occupies just the position of the intermedium, in a carpus that has been preserved in a very perfect manner, and it fits the position it occupies very accurately. According to this interpretation there are two centrale. There are four bones in the distal row of the carpus; the first is very much larger than the others, and appears to represent the first and second combined; the outer edge is a rounded process, with no face for articulation with another carpal. It is possible that the first metacarpal was attached to this bone with the second, but no traces of such a metacarpal remain. The metacarpals are short and stout, with well-developed articular condyles. The phalanges are not in contact with metacarpals, but a series which corresponds very closely to the fourth in size shows that they were also very short and strong. It is impossible to say whether there were more than three phalanges or not. Fig. 7 shows the arrangement of the bones very little altered from their position in the matrix.

The posterior limb is represented by the ends of the femur and of the tibia and fibula. The femur shows well-developed

articular surfaces. The tibia shows on the anterior end the deep groove which defines the cnemial crest.

The tarsus of the left foot is preserved, but the bones are somewhat displaced. There are eight bones. The most interesting thing about the foot is the fact that the proximal row is composed of two greatly enlarged bones that can only be astragalus and calcaneum; the astragalus is the larger, with strong articular faces for the calcaneum, and for the first and second tarsals of the distal row. The calcaneum is a large, round, and very thin bone that is preserved in the natural position; it articulates with tibia in common with the astragalus. The other bones of the tarsus are out of position, but one triangular-shaped bone lies over the astragalus and calcaneum; this seems to be the intermedium or, more likely, the centrale (naviculare); the intermedium having joined the tibiale to form the astragalus.

The five remaining bones are considered as belonging to the distal row, and the largest has been placed as the fifth, the fourth and fifth not having yet united to form the cuboid.

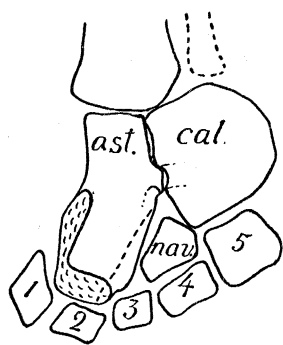


FIG. 8.

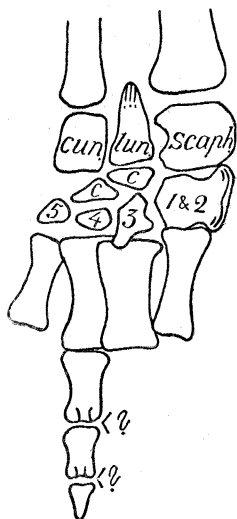


FIG. 7.

There is a separate fragment of bone that is so poorly preserved that it is impossible to say whether it is a complete bone or not; if it is it may be either a second centrale or the intermedium (Fig. 8).

The discovery of the well-differentiated astragalus and calcaneum throws a new light on the position of the *Cotylosauria*, for the proximal row of the tarsus in *Pareiasaurus*, as figured by Seeley, consists of a single bone; this difference must be considered as evidence in favor of the independence of Cope's order *Cotylosauria* from the *Pareiasauria*.

It will be seen that in many places the form here described departs from Cope's description of the type *Pariotichus incisivus*, but it seems best to assign it to the form which the previous fragmentary description most nearly indicates, and avoid the introduction of a new name until it may become necessary.

Measurements :

Greatest length interclavicle	77 mm.
Greatest breadth head of interclavicle	23.5
Antero-posterior length of scapula coracoid	52.5
Breadth of same at humeral cotylus	36
Length of head on median line from back to point opposite middle of nares	120.5
Interorbital width	26
Breadth of skull at posterior end	127
Breadth across orbits	80
Breadth across nares (approximate)	30
Length lower jaw	150
Greatest length humerus	66
Breadth lower end humerus	30
Breadth lower end femur	26.5

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